Problem 2.4: Complex-valued Signals

Complex numbers and phasors play a very important role in electrical engineering. Solving systems for complex exponentials is much easier than for sinusoids, and linear systems analysis is particularly easy.

1. Find the phasor representation for each, and re-express each as the real and imaginary parts of a complex exponential. What is the frequency (in Hz) of each? In general, are your answers unique? If so, prove it; if not, find an alternative answer for the complex exponential representation.
   1. $3sin(24t)$
   2. $\sqrt{2}cos(2\pi 60t + \frac{\pi}{4})$
   3. $2cos(t + \frac{\pi}{6}) + 4sin(t - \frac{\pi}{3})$
2. Show that for linear systems having real-valued outputs for real inputs, that when the input is the real part of a complex exponential, the output is the real part of the system's output to the complex exponential (see the below figure).

$$S(Re(Ae^{j2\pi ft})) = Re(S(Ae^{j2\pi ft}))$$